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June 15, 1995
SP307:061595:01

Mr. Andy Ledford
EG&G Rocky Flats, Inc.
Rocky Flats Environmental Technology Site
P.O. Box 464, Building 080
Golden, Colorado 80402-0464

Subject: MTS 343756 GG
OU4 Solar Ponds IM/IRA
Durability of the Low-Permeability Layer

Dear Mr. Ledford:

Mr. Timinskas of your staff has raised a concern with respect to the long-term durability and functionality of the asphaltic low-permeability composite layer in the OU4 IM/IRA design. The basic premise of the concern is that asphaltic materials contain organic solvents which volatilize over time. Mr. Timinskas believes this volatilization may cuase a degradation of the asphalt which could result in a reduction in its low-permeability characteristics. Mr. Timinskas has spoken with asphalt chemists who have indicated that the asphaltic composite may only function as intended for 50-100 years. Mr. Timinskas spoke with members of the Hanford Engineered Barrier Research team who indicated that their research funding had been cut before stress/age testing had been accomplished. Therefore, accelerated age testing results are not currently available and the Hanford Engineered Barrier research team cannot substantiate the long-term durability of the asphaltic materials. Additional details are presented in the meeting minutes from a May 22, 1995 meeting (Attachment 1).

Parsons ES and Deery Oil have contacted members of the Hanford Barrier research team to investigate the details concerning their apparent withdrawal of support for asphaltic materials for low-permeability layers. Deery Oil supplied the liquid applied asphalt membrane for the Hanford barrier prototype, and has also worked with Parson ES to develop and test a liquid applied asphalt formula for the OU4 IM/IRA design. The Hanford barrier research team cannot prove (with test results) the durability and longevity of asphaltic materials, but they continue to support the use of asphaltic materials for long-term engineered barriers. They support asphaltic materials because they are as good and appear to be better than the available alternatives. The results of the Hanford research lead the researchers to the opinion that if they were building the prototype over again, they would still use asphaltic materials for the low-permeability layer. Notice of telephone conversation SP307:052695:01 dated May 25, 1995 (Attachment 2) provides information concerning a discussion that Parsons ES has had with a member of the Hanford barrier research team.

It is important to note that long-term durability/functionality testing does not exist for any of the available low-permeability materials to periods of 1,000-years. Therefore, the selection of a

(I:\PROJECTS\722446\CORRESP\06159501.WPF\06/15/95) low-permeability material must be made at least partly on faith and engineering judgement. Parsons ES and the Hanford barrier team concur that asphaltic materials are an appropriate choice for implementation in semi-arid environments. The primary alternative low-permeability materials include:

1. Clay materials, and
2. Human-made flexible membrane liners (FMLs).

Clay materials are commonly used in moist environments where there is adequate precipitation to keep the clay hydrated. In semi-arid and arid environments clay is prone to cracking due to desiccation. A low-permeability clay layer would be ineffective in the long-term because the clay will desiccate due to the RFETS environment. Over time, cracks will develop in a clay layer because the capillary break will keep moisture away from the clay. The application of the asphalt layer is anticipated to be more cost effective than a clay layer because the typical RCRA engineered cover utilizes 2-3 feet of clay which is costly to purchase, transport, and install. The asphaltic composite is less than 1 foot in thickness, provides a lower-permeability than clay, and requires less transportation and installation costs. There is no long-term test results demonstrating that clay low-permeability layers will remain functional for periods up to or exceeding 1,000 years.

Some FMLs have high density and are chemically inert which make them excellent low-permeability materials for use at hazardous waste sites. FMLs are applied in thin layers which reduce transportation and installation costs. The primary problem with FMLs is that the sheets must be welded together. The welds must be subjected to intense QA/QC scrutiny and over time, the seams could be the weak link in the functionality of the low-permeability system. There is no long-term test results demonstrating that FMLs will remain functional for periods up to or exceeding 1,000 years. Recent accelerated age testing has been performed on FMLs and these studies indicate that FMLs may last for periods between 200 and 300 years.

Recently, there have been products introduced which couple a thin layer of clay adhered to a FML. These products gain some of the advantages of clay with the advantages of plastic materials. However, seaming sheets of the materials could be problematic. There are no long-term test results demonstrating that these materials may last for periods up to or exceeding 1,000 years.

In summary, there are no long-term test results for any of the low-permeability material alternatives which prove that a material will function for a 1,000-year period. Therefore, the selection of the material has been made based on the best available data in conjunction with engineering judgement. It is important to note that the low-permeability layer will act as a secondary measure to prevent infiltration in that the capillary break, in conjunction with evapotranspiration, is the primary means of infiltration abatement. The DOE, EPA, and CDPHE jointly made the decision to select and defend the use of asphaltic materials. The public has shown initial hesitancy with respect to the use of asphalt, but has largely approved of the concept when they have seen samples from the Hanford prototype, and have learned that the material will be protected from the primary means of asphalt degradation:

1. UV light,
2. Freeze/thaw cycles,
3. Dynamic loading/stress, and
4. Excess moisture (asphalt stripping)

The DOE received no adversarial comments on the proposed IM/IRA-EA Decision Document from the public, or the regulatory agencies with respect to the use of asphaltic materials. During a DOE-HQ review of the conceptual design, HAZRAP praised the design.

Based on the information presented above Parsons ES recommends that asphaltic materials be retained in the design of the OU4 IM/IRA. However, investigations are ongoing to assess the potential for improving the design so that the asphaltic materials may have a higher potential to remain functional for periods of 1,000-years or greater.

Mr. Timinskas has learned that natural asphaltic materials are thought to have superior longevity in comparison to human-made asphaltic materials because the rate of degradation (oxidation) is less. Natural asphaltic materials are commercially available. Natural asphalts are available from Trinidad Lake Asphalt. There are also natural asphalts (Gilsonite) mined in Western Colorado and eastern Utah.

Trinidad Lake Asphalt is a natural material that bubbles to the top of Trinidad Lake. This material is not pure in that it contains a high concentration of sand (silica). Trinidad Lake asphalts have been utilized for 400 years for roads and roofs. These materials are normally "cold applied" by hand techniques (trowel).

Gilsonite is a natural asphalt that is commercially available. This material has a very low penetration value which means that it is very stiff (particularly at low temperatures). This material has been used to encapsulate radioactive wastes at nuclear power generating stations.

Parsons ES has investigated whether the natural asphaltic materials could be used as raw materials for the production of the liquid applied asphalt or the asphaltic concrete. (See attachment 3 and 4). The following is a discussion of the information that has been collected to date.

Deery Oil indicates that Trinidad Lake Asphalt cannot be used for the liquid applied asphalt because the high sand content will clog the application nozzles. It is possible to process Trinidad Lake asphalt to remove the sand. However, the processing may cause the Trinidad Lake materials to behave like other human-processed asphalts (increased oxidation/degradation rate).

It might be possible to "cold apply" the Trinidad Lake asphalt as a substitute for the liquid applied layer. However, hand application of 11 acres of asphalt would be very time-consuming and costly to install. In addition, a hand applied asphalt membrane would be very difficult with respect to QA/QC during placement. The Trinidad Lake materials are generally less flexible than the Deery Oil product which would make them less resilient to structural stresses and less likely to show self-healing properties. There is also a question with respect to ensuring that there are no holes during installation if the asphalt is hand applied.

Use of Trinidad Lake material for asphaltic concrete is possible. The regional supplier of Trinidad Lake asphalt recommends that the Trinidad Lake Asphalt be blended with processed asphalt material to produce a workable asphalt that would not be too stiff at low temperatures.

A supplier of Gilsonite indicated that this material could be used within the asphalt membrane and/or in the asphaltic concrete layer, but it would need to be blended with processed asphalt to produce a workable asphalt.

If a natural asphalt is either used in the polymer modified asphalt material or is completely substituted for the polymer modified asphalt, several issues must be investigated. These issues include:

1. Determining if a natural asphalt can be blended and applied as a fluid applied asphalt;

2. Determining if a natural asphalt can be hand applied (by trowel or spreaders) while retaining low hydraulic conductivity, and adequate quality control during placement; and

3. Determining if a natural material will excessively creep under the imposed loads of the cover.

If a natural asphalt is used in the asphalt concrete mix design, several issues must be investigated. These issues include:

1. Determining the mix design characteristics through performance of a Marshall Analysis;

2. Determining if the mix meets stability criteria; and

3. Determining if the designed mix can be easily applied during construction.

Parsons ES contacted PRI Asphalt Technologies to discuss the degradation of asphalt. During these discussions, it was learned that the volatiles contained in asphalt are almost completely lost during the hot mixing operations. Therefore, the only degradation mechanism is oxidation. PRI Asphalt Technologies has been involved in age testing of asphalt. They have found that temperature is the primary factor controlling oxidation. A constant temperature of approximately 58° F (anticipated temperature under the engineered cover) is considered to be low. Therefore, oxidation is not expected to be a major problem.

Based on the discussions that have taken place with technical specialists, Parsons ES considers that the current design will function to adequately protect human health and the environment. However, if the DOE decides to modify the current IM/IRA design to gain additional confidence in the long-term functionality, then Parsons ES recommends the following course of action to enhance the effectiveness of the low permeability-layer. A seal coat can be applied upon the gravel base course. The asphaltic concrete would be installed above the prime coat. The prime coat will prevent oxidation of the asphaltic concrete from below by filling in the voids within the gravel base course. It will be important from a constructability aspect to identify and specify a liquid applied prime coat. The asphalt concrete mix can be changed to include a blend of natural asphalt with processed asphalt. This will enhance the longevity of the asphaltic concrete. The following activities will be required to implement the modification to the asphaltic concrete:

1. Determine the mix design characteristics through performance of a Marshall Analysis,

2. Determine if the mix meets stability criteria,

3. Determine if the design mix can be easily constructed, and

4. Demonstrating that the hydraulic conductivity is less than or equal to $1.0x10^{-7}$ cm/sec.

Parsons ES anticipates that the asphaltic concrete mix can be designed and installed to achieve the RCRA target hydraulic conductivity of less than or equal to $1.0x10^{-7}$ cm/sec. To ensure low-permeability (hydraulic conductivity less than $1.0x10^{-7}$ cm/sec) the air void content of an asphalt concrete lining should not exceed 4 percent (the Asphalt Institute, Manual Series No. 12, MS-12, 1976). The asphaltic concrete would be the primary low-permeability component of the low-permeability composite. The use of the natural asphalt may enhance the longevity of this layer. The liquid applied polymer modified asphalt (Deery Oil's Membrane 6) would be applied above the asphaltic concrete to provide a low-permeability flexible layer that will function as follows:

1. Provide a seal on the asphaltic concrete to reduce oxidation, and

2. Provide resiliency in the event that the asphaltic concrete cracks due to differential settlement or a minor seismic event.

Parsons ES does not consider that it is necessary to enhance the liquid applied polymer modified asphalt with natural asphalt material because the natural materials would provide stiffness which would reduce the resiliency. In addition, it would be difficult to apply the stiffer membrane as a liquid. The Deery Oil polymer modified material has been specially formulated to meet the OU4 criteria for:

1. Hydraulic conductivity,
2. Flexibility, and
3. Creep.

Considerable costs have been expended in this material which meets all RCRA requirements. Deery Oil polymer modified material has not been proven to have the ability to function for the 1,000-year design period. As stated previously, this weakness exists for all of the candidate barrier materials.

The Parsons ES recommendation was discussed in a meeting held on June 1, 1995 (Meeting Minutes SP307:060595:02, Attachment 5). In summary, Parsons ES considers that the current IM/IRA design will provide adequate protection to human health and the environment. However, a recommendation has been made to enhance the asphaltic concrete with natural asphaltic materials if the DOE considers that it is appropriate to ensure additional confidence in the durability of the design. The advantage to this recommendation is that it would allow the DOE to gain additional confidence in the long-term functionality of the OU4 IM/IRA design without losing costs that have been sunk into the current design. The disadvantage is that testing and research will be necessary for the asphaltic concrete which will have a cost and schedule impact.

Please call me at 764-8811 or pager 687-2551 if you have any questions.

Sincerely,

Philip A. Nixon
Project Manager: Solar Pond IM/IRA

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